



# 2014 CAPS Spring Forecast Experiment Program Plan

April 28, 2014

(Contact: Fanyou Kong, [fkong@ou.edu](mailto:fkong@ou.edu))



## Table of Contents

1. Overview of New Features for 2014 Season .....	3
2. Program Duration.....	3
3. Multi-model Forecast System Configuration.....	4
3.1 4-km grid storm-scale ensemble forecasts (SSEF) initialized at 00 UTC .....	4
3.2 4-km SSEF initialized at 12 UTC .....	6
3.3 Experimental 4-km EnKF SSEF initialized at 00 UTC .....	6
4. Forecast Product and Deliverables to HWT .....	9
4.1 Products available to HWT (NSSL/SPC, HPC) in GEMPAK .....	9
4.2 Post-processed ensemble products in GEMPAK.....	12
* Highlighted variables in Tables 5 and 6 are not yet available.....	17
4.3 Products that will be extracted and archived as 2D HDF4 files .....	17
4.4 Name convention .....	21
5. 3D Visualization .....	22
Appendix.....	23

# 1. Overview of New Features for 2014 Season

## **Major features for 2014:**

- WRF version 3.5.1 is used for 2014 season. (ARPS v5.3.5)
- 24 4-km SSEF members, with 60-h forecast initiated at 0000 UTC, running at NICS
- 8 4-km SSEF members over CONUS, with 24 h forecast initiated at 1200 UTC, running on Boomer at OSCER
- Two NWP models: WRF-ARW (20), COAMPS (4)
- **EnKF ensemble forecasting experiment:** with up to 40-member storm-scale ensemble background, a one hour EnKF cycling at 15 min interval, and a 12-member ensemble forecast (24-h) forecast starting at 0000 UTC, running on the same CONUS domain (see Figure 1)
- 3D visualization (Keith)

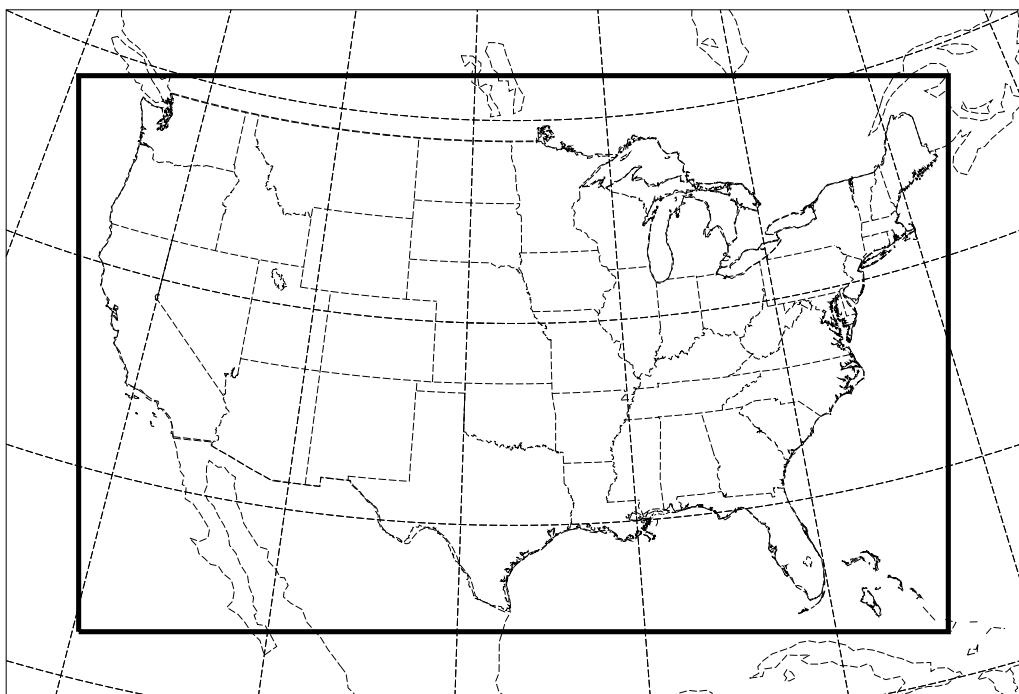


Figure 1. The computational domain for the 2014 Season (dark line) for both HWT and EnKF forecasts (outer domain: 1200×768).

## 2. Program Duration

From **21 April 2014** through **6 June 2014**

The 2014 SPC/NSSL HWT Spring Experiment, a joint effort among NOAA Storm Prediction Center (SPC) and National Severe Storm Laboratory (NSSL) and the Center for Analysis and Prediction of Storms (CAPS) at University of Oklahoma, will officially **start on 5 May and end on 6 June**, with five days a week (Monday through Friday). CAPS 2014 Spring Program begins

regular forecast production two weeks earlier on 21 April to identify possible issues and to provide training sample dates for QPF calibration, and remains five days a week (running forecasts on the night of Sunday through Thursday) with possible weekend runs upon SPC request according to weather circumstance.

### 3. Multi-model Forecast System Configuration

Four NWP modeling systems, WRF-ARW, the Navy COAMPS model system, and the ARPS model system, are used in 2014 Spring Experiment. All forecasts use **51** vertical levels. WRF code (both cores) was modified by CAPS to allow initial hydrometeor fields generated from 3DVAR/ARPS Cloud analysis of WRS-88D radar reflectivity to pass into WRF initial condition, and (for ARW) to write out reflectivity field every 5 min. ARPS members have the same horizontal grid as WRF-ARW.

#### 3.1 4-km grid storm-scale ensemble forecasts (SSEF) initialized at 00 UTC

SSEF forecasts are generated with both dynamical cores (solvers) of the Weather Research and Forecast (WRF) modeling system (**Version 3.5.1**), the Advanced Research WRF (ARW) core, the Advanced Regional Prediction System (ARPS **v5.3.5**) developed by CAPS, University of Oklahoma, and the Navy COAMPS model. As in 2012 season, the 00Z NAM analyses available on the 12 km grid (218) are used for initialization of control and non-perturbed members and as first guess for initialization of perturbed members with the initial condition perturbations coming directly from the NCEP Short-Range Ensemble Forecast (SREF). SREF data with Grid 132 data form are directly processed. WSR-88D data, along with available surface and upper air observations, are analyzed using ARPS 3DVAR/Cloud-analysis system. Forecast output at hourly intervals (higher time frequency output for a limited selection of 2D fields) are archived at the NICS mass storage (HPSS).

The *daily* ensemble forecast configuration includes the following, all of which are run on **Darter**, a brand new Cray XC30 system with over 12,000 cores at NICS. CAPS SSEF forecasts will have dedicated access to the system over the project period.

- **ARW:** 20-member ensemble at 4 km grid spacing initialized at 00 UTC. Model execution begins around 0130 UTC (8:30pm CDT) and finish in 6-8 hours, with results being processed as they become available. **Table 1** lists the configuration and physics options for each ARW member. All forecasts are 60 h.
- **COAMPS:** 4-member COAMPS forecasts at 4-km grid spacing, initialized at 00 UTC. **Table 2** lists the configurations.

*Table 1. Configurations for ARW members. NAMa and NAMf refer to 12 km NAM analysis and forecast, respectively. ARPSa refers to ARPS 3DVAR and cloud analysis.*

Member	IC	BC	Radar data	Microphy	LSM	PBL
*arw_cn	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	MYJ
arw_c0	00Z ARPSa	00Z NAMf	no	Thompson	Noah	MYJ
arw_m3	arw_cn + em-p1_pert	21Z SREF em-p1	yes	Morrison	RUC	YSU
*arw_m4	arw_cn + em-n2_pert	21Z SREF em-n2	yes	Thompson	Noah	QNSE
*arw_m5	arw_cn + nmm-p1_pert	21Z SREF nmm-p1	yes	Morrison	Noah	MYNN
*arw_m6	arw_cn + nmmb-n1_pert	21Z SREF nmmb-n1	yes	MY2	RUC	MYJ
arw_m7	arw_cn - nmmb-p1_pert	21Z SREF nmmb-p1	yes	WDM6	Noah	YSU
*arw_m8	arw_cn + em-n1_pert	21Z SREF em-n1	yes	WDM6	Noah	QNSE
arw_m9	arw_cn - em-p2_pert	21Z SREF em-p2	yes	MY2	Noah	MYNN
*arw_m10	arw_cn - nmmb-n3_pert	21Z SREF nmmb-n3	yes	Morrison	Noah	YSU
*arw_m11	arw_cn - nmmb-p3_pert	21Z SREF nmmb-p3	yes	Thompson	RUC	YSU
*arw_m12	arw_cn - em-p3_pert	21Z SREF em-p3	yes	Thompson	Noah	MYNN
arw_m13	arw_cn - nmm-p2_pert	21Z SREF nmm-p2	yes	Morrison	Noah	QNSE
arw_m14	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	MYNN
arw_m15	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	YSU-T
arw_m16	00Z ARPSa	00Z NAMf	yes	Thompson	Noah	YSU
arw_m17	00Z ARPSa	00Z NAMf	yes	MY2	Noah	MYJ
arw_m18	00Z ARPSa	00Z NAMf	yes	MY	Noah	MYJ
arw_m19	00Z ARPSa	00Z NAMf	yes	Milbrant-Morrison	Noah	MYJ
arw_m20	00Z ARPSa	00Z NAMf	yes	Morrison	Noah	MYJ

Note 1: For all members:  $ra\_lw\_physics$ = RRTMG;  $ra\_sw\_physics$ =RRTMG;  $cu\_physics$ =none

Note 2: MY2 is a modified version of Milbrandt-Yau microphysics scheme; YSU-T is the Thompson modified YSU PBL scheme

Note 3: m19 uses the newly developed P3 (Morrison-Milbrandt) microphysics

*Table 2. Configurations for each individual member with COAMPS*

Member	IC	BC	Radar data	Microphy.	PBL
cmps_cn	00Z ARPSa	00Z NAMf	yes	Hobbs-Rutledge	Mellor-Yamada
cmps_c1	00Z ARPSa	00Z NAMf	yes	Thompson	Mellor-Yamada
cmps_c2	00Z ARPSa	00Z NAMf	yes	M-Y	Mellor-Yamada
cmps_c3	00Z ARPSa	00Z NAMf	yes	Thompson	YSU

\* For all members: no cumulus parameterization

**\*\* Members in red are contributing members for HWT (12 totals).**

### 3.2 4-km SSEF initialized at 12 UTC

As in 2013 Spring Experiment season, a second set of 8-member 4-km SSEF forecasts over the CONUS domain (see Figure 1) are produced locally on OSCER facility (*Boomer*), using the same configuration as a set of SSEF members initiated at 00 UTC. The forecast is initialized from 12 UTC and last 18 h.

Eight members are run at 12 UTC:

ARW: **cn, m4, m5, m6, m8, m10, m11, m12** (refer to Table 1)

### 3.3 Experimental 4-km EnKF SSEF initialized at 00 UTC

A separate 4-km ensemble of 24h forecasts, starting at 1800 UTC, with 40 WRF-ARW members is produced over the CONUS domain. This ensemble is configured with initial perturbations and mixed physics options to provide input for EnKF analysis. Each member uses WSM6 microphysics with different parameter settings (see Table 3). All members also include random perturbations with recursive filtering of ~20 km horizontal correlations scales, with relatively small perturbations (0.5K for potential temperature and 5% for relative humidity).

EnKF analysis (cycling), with radar data and other conventional data, is performed from 23 to 00 UTC every 15 min over the CONUS domain, using as background the 40-member ensemble in Table 3. A 12- member ensemble forecast (24h) follows using the 00 UTC EnKF analyses (see Table 4).

*Table 3. Configuration for the EnKF ensemble*

Member	IC	BC	Microphy – WSM6 (N0r, N0g, pg) <sup>*</sup>	LSM	PBL
enk_m1	18Z NAMa	18Z NAMf	(8,6),(4,6),500	Noah	MYJ
enk_m2	enk_m1 + em-p1_pert	18Z SREF em-p1	(8,6),(4,6),500	Noah	YSU
enk_m3	enk_m1 + nmm-n2_pert	18Z SREF nmm-n2	(9.4,6),(5,4),673	Noah	MYJ
enk_m4	enk_m1 + em-n2_pert	18Z SREF em-n2	(2.4,7),(5.7,4),666	Noah	ACM2
enk_m5	enk_m1 + nmmb-p2_pert	18Z SREF nmmb-p2	(3.7,7),(6.3,4),659	Noah	ACM2
enk_m6	enk_m1 + nmm-p1_pert	18Z SREF nmm-p1	(2.5,6),(8,4),652	Noah	MYNN
enk_m7	enk_m1 + nmmb-n1_pert	18Z SREF nmmb-n1	(2.6,7),(9,4),645	Noah	MYJ
enk_m8	enk_m1 – nmmb-p1_pert	18Z SREF nmmb-p1	(6.8,6),(1,5),638	Noah	YSU
enk_m9	enk_m1 + em-n1_pert	18Z SREF em-n1	(3,6),(1.1,5),631	Noah	QNSE
enk_m10	enk_m1 – em-p2_pert	18Z SREF em-p2	(8.4,6),(1.3,5),624	Noah	MYNN
enk_m11	enk_m1 – nmmb-n3_pert	18Z SREF nmmb-n3	(1.5,7),(1.4,5),617	Noah	MYJ
enk_m12	enk_m1 – nmmb-p3_pert	18Z SREF nmmb-p3	(3.1,6),(1.6,5),610	Noah	YSU
enk_m13	enk_m1 – em-p3_pert	18Z SREF em-p3	(8.6,5),(1.8,5),603	Noah	ACM2
enk_m14	enk_m1 – nmm-p2_pert	18Z SREF nmm-p2	(4.6,6),(2,5),596	Noah	QNSE
enk_m15	enk_m1 + em-p1_pert	18Z SREF em-p1	(1.3,7),(2.2,5),589	Noah	MYNN
enk_m16	enk_m1 + nmm-n2_pert	18Z SREF nmm-n2	(5.1,6),(2.5,5),582	Noah	ACM2
enk_m17	enk_m1 + em-n2_pert	18Z SREF em-n2	(8.1,5),(2.8,5),575	Noah	MYJ
enk_m18	enk_m1 + nmmb-p2_pert	18Z SREF nmmb-p2	(1.9,6),(3.2,5),568	Noah	ACM2
enk_m19	enk_m1 + nmm-p1_pert	18Z SREF nmm-p1	(3.9,7),(3.6,5),561	Noah	MYJ

enk_m20	enk_m1 + nmmmb-n1_pert	18Z SREF nmmmb-n1	(2.2,6),(4,5),554	Noah	QNSE
enk_m21	enk_m1 – nmmmb-p1_pert	18Z SREF nmmmb-p1	(8.5,6),(4.5,5),547	Noah	MYJ
enk_m22	enk_m1 + em-n1_pert	18Z SREF em-n1	(1.1,7),(5,5),540	Noah	MYJ
enk_m23	enk_m1 – em-p2_pert	18Z SREF em-p2	(8.1,5),(5.7,5),533	Noah	YSU
enk_m24	enk_m1 – nmmmb-n3_pert	18Z SREF nmmmb-n3	(1,7),(6.4,5),526	Noah	QNSE
enk_m25	enk_m1 – nmmmb-p3_pert	18Z SREF nmmmb-p3	(2.2,7),(7.1,5),519	Noah	MYNN
enk_m26	enk_m1 – em-p3_pert	18Z SREF em-p3	(7.2,6),(8,5),512	Noah	MYJ
enk_m27	enk_m1 – nmm-p2_pert	18Z SREF nmm-p2	(8.9,6),(9,5),505	Noah	YSU
enk_m28	enk_m1 – nmmmb-p3_pert	18Z SREF nmmmb-p3	(2.9,7),(1,6),498	Noah	ACM2
enk_m29	enk_m1 – em-p3_pert	18Z SREF em-p3	(1.1,7),(1.1,6),491	Noah	QNSE
enk_m30	enk_m1 – nmm-p2_pert	18Z SREF nmm-p2	(9.6,6),(1.3,6),484	Noah	MYJ
enk_m31	enk_m1 + em-p1_pert	18Z SREF em-p1	(3.1,6),(1.4,6),477	Noah	QNSE
enk_m32	enk_m1 + nmm-n2_pert	18Z SREF nmm-n2	(1.3,6),(1.6,6),470	Noah	MYNN
enk_m33	enk_m1 + em-n2_pert	18Z SREF em-n2	(2,6),(1.8,6),463	Noah	MYJ
enk_m34	enk_m1 + nmmmb-p2_pert	18Z SREF nmmmb-p2	(4.4,6),(2,6),456	Noah	YSU
enk_m35	enk_m1 + nmm-p1_pert	18Z SREF nmm-p1	(1.7,6),(2.2,6),449	Noah	ACM2
enk_m36	enk_m1 + nmmmb-n1_pert	18Z SREF nmmmb-n1	(4.3,6),(2.5,6),442	Noah	QNSE
enk_m37	enk_m1 – nmmmb-p1_pert	18Z SREF nmmmb-p1	(1.3,6),(2.8,6),435	Noah	MYNN
enk_m38	enk_m1 + em-n1_pert	18Z SREF em-n1	(9.1,5),(3.2,6),428	Noah	MYJ
enk_m39	enk_m1 – em-p2_pert	18Z SREF em-p2	(5,6),(3.6,6),421	Noah	YSU
enk_m40	enk_m1 – nmmmb-n3_pert	18Z SREF nmmmb-n3	(6.1,6),(3.9,6),414	Noah	MYJ

\* For N0r and N0h, (a, b) are coefficients of  $a \times 10^b$ .

*Table 4. Configuration for the EnKF 12-member ensemble forecasts*

Member	IC	BC	Microphysics	LSM	PBL
enkf_m1	enk_m1a	arw_cn	Thompson	Noah	MYJ
enkf_m2	enk_m2a	arw_m3	MY2	Noah	MYJ
enkf_m3	enk_m3a	arw_m4	Morrison	Noah	MYJ
enkf_m6	enk_m6a	arw_m5	Thompson	Noah	MYNN
enkf_m7	enk_m7a	arw_m6	MY2	Noah	YSU
enkf_m8	enk_m8a	arw_m7	Morrison	Noah	YSU
enkf_m9	enk_m9a	arw_m8	Thompson	Noah	QNSE
enkf_m10	enk_m10a	arw_m9	MY2	Noah	MYNN
enkf_m11	enk_m11a	arw_m10	Thompson	Noah	YSU
enkf_m12	enk_m12a	arw_m11	WDM6	Noah	YSU
enkf_m15	enk_m15a	arw_m12	Morrison	Noah	MYNN
enkf_m16	enk_m16a	arw_m13	WDM6	Noah	MYJ

## 4. Forecast Product and Deliverables to HWT

### 4.1 Products available to HWT (NSSL/SPC, HPC) in GEMPAK

The NSSL/SPC required list of forecast fields for 2014 HWT Spring Experiment is listed in Table 5. Variables with field name underlined are hourly maximum. 45 total fields.

In order to keep realtime data flow into NSSL/SPC server low, the NSSL/SPC GEMPAK fields are over a sub-domain emphasizing the east part of the CONUS. Figure 2 is the desired sub-domain (860×690 grid points in horizontal), which stays exactly the same as past years. A complete set of extracted 2D fields (Table 7) over the full CONUS domain are archived by CAPS for post-analysis and external collaborations.

Two separate sets of variables may also be packaged for NSSL/SPC: 1) composite, 1km, -10C reflectivity every 6-min in the first 6 h of the forecasts with radar data analysis (ENKF plus C0 and CN) and 2) A netcdf file with the variables in the table with a \* including these variables: Bunkers u and v, echotops, PWAT, downdraftmax, 850 spec hum, 2m qv in addition to the starred variables at this moment

8 member subset ensemble fields for 00z are generated for comparison with the 8 member ensemble from 12z.

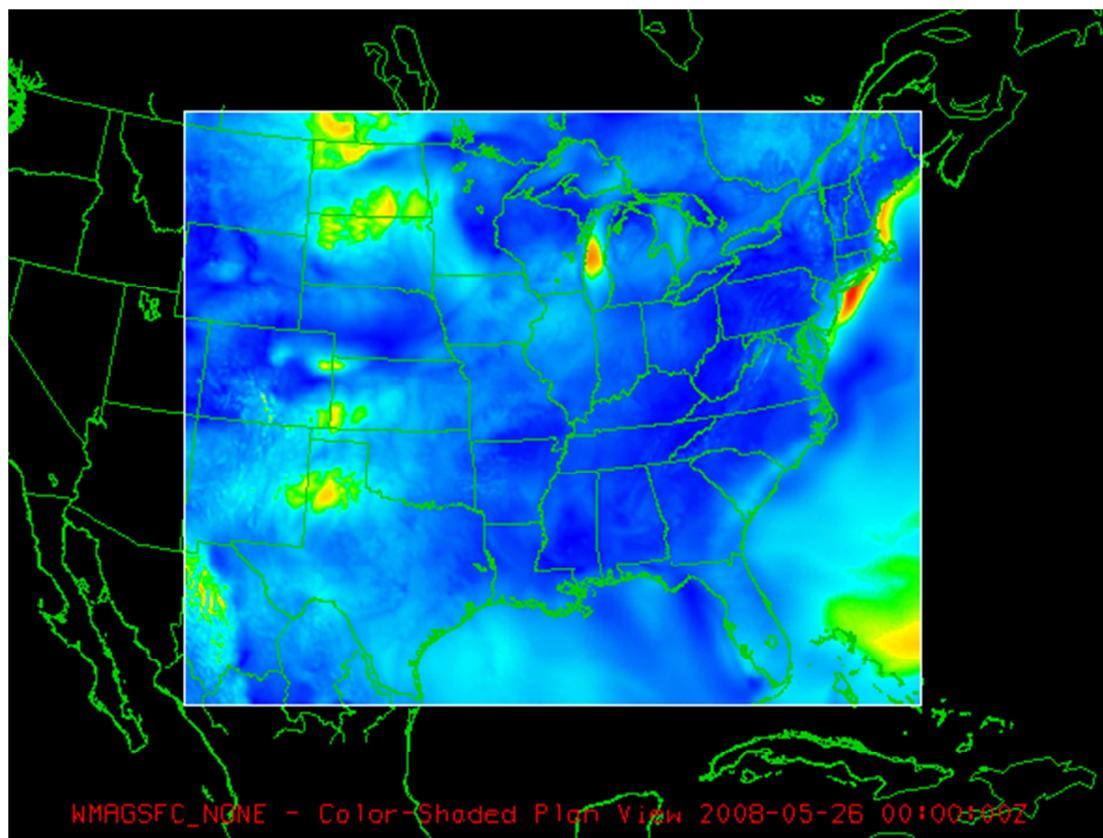


Figure 2. NSSL/SPC sub-domain for the GEMPAK dataset (850×690).

Table 5. 2D fields of each member for NSSL/SPC

Field	GEMPAK name	Unit	Type	Level
Surface pressure	PRES	hPa	Surface/single layer	0
Sea level pressure	PMSL	hPa	Surface/single layer	0
1-h precipitation	P01M	mm	Surface/single layer	0
Temperature at lowest model level	TMPF*	F	Surface/single layer	0
Dew point at lowest model level	DWPF*	F	Surface/single layer	0
10 m U	UREL	m/s	Surface/single layer	0

10 m V	VREL	m/s	Surface/single layer	0
Surface wind speed (10-m)	WMAGSFC*	m/s	Surface/single layer	0
U lowest model level	URELM	m/s	Surface/single layer	0
V lowest model level	VRELM	m/s	Surface/single layer	0
Wind speed max lowest model level	WMAGM*	m/s	Surface/single layer	0
1 km AGL reflectivity	REFL1KM*	dBZ	Surface/single layer	0
1 km AGL reflectivity	REFL1KM_HM	dBZ	Surface/single layer	0
Composite reflectivity	REFLCMP*	dBZ	Surface/single layer	0
Composite reflectivity	REFLCMP_HM	dBZ	Surface/single layer	0
Reflectivity at -10 C	REFLMTR*	dBZ	Surface/single layer	0
Surface-based CAPE	CAPE*	J/kg	Surface/single layer	0
Moist unstable CAPE	MUCAPE*	J/kg	Surface/single layer	0
Surface-based CIN	CINS	J/kg	Surface/single layer	0
Moist unstable CIN	MUCINS*	J/kg	Surface/single layer	0
Surface-based LCL	HLCL*	m	Surface/single layer	0
0-1 km AGL SRH	SRH01*	m <sup>2</sup> /s <sup>2</sup>	Surface/single layer	0
0-3 km AGL SRH	SRH03*	m <sup>2</sup> /s <sup>2</sup>	Surface/single layer	0
Updraft helicity	VHEL*	m <sup>2</sup> /s <sup>2</sup>	Surface/single layer	0
0-3 km Updraft helicity	VHEL3KM*	m <sup>2</sup> /s <sup>2</sup>	Surface/single layer	0
Sfc-400 hPa max W	VVELMAX*	m/s	Surface/single layer	0
0-1 km AGL wind shear	SHR01*	1/s	Surface/single layer	0
0-6 km AGL wind shear	SHR06*	1/s	Surface/single layer	0
Vertical-integrated Qg	COLQG*	kg/ m <sup>2</sup>	Surface/single layer	0

<u>Vertical-integrated (0-5km) Qg</u>	<u>LLQG*</u>	kg/m <sup>2</sup>	Surface/single layer	0
Lightning Threat 3	<u>LTG3_MAX</u>	Flashes/k m <sup>2</sup> /5min	Surface/single layer	0
<u>HAIL Size</u>	<u>HAIL*</u>	inches	Surface/single layer	0
Simulated Satellite Ch. 10.67 BT	SIMSAT3	K	Surface/single layer	0
Sim Satellite Ch. 6.48 BT	SIMSAT2*	K	Surface/single layer	0
<u>maxWind speed (1-km)</u>	<u>WMAG1kmMax</u>	m/s	Surface/single layer	0
Pressure 1km	Pres1km	mb	Surface/single layer	0
Temperature 1km	TMPC1km	C	Surface/single layer	0
Dew Point 1km	DWPC1km	C	Surface/single layer	0
U wind 1km	UREL1km	m/s	Surface/single layer	0
V wind 1km	VREL1km	m/s	Surface/single layer	0
W wind 1 km	VVEL1km*	m/s	Surface/single layer	0
mixed-layer CAPE	MLCAPE*	J/kg	Surface/single layer	0
mixed-layer CIN	MLCIN*	J/kg	Surface/single layer	0
0 – 3 km AGL lapse rate	LLL* LR75*	K/km	Surface/single layer	0
700 – 500 mb lapse rate	LR75*	K/km	Surface/single layer	0
<u>ClarkCon given sbcape/mucape&gt;= .75 and LCL &lt; 1500m</u>	<u>CLCON</u>	m <sup>2</sup> /s <sup>2</sup>	surface/single layer	0

Note 1: Simulated satellite BTs: GOES-13 (3.9um, 6.48um, 10.7um)

Note 2: Accumulated graupel is the graupel liquid equivalent surface accumulation.

## 4.2 Post-processed ensemble products in GEMPAK

A list of post-processed ensemble products are produced for NSSL/SPC for the 2014 HWT Spring Experiment (see Table 6). The 12 baseline ensemble members contribute to the products, they are:

arw\_cn, arw\_m3~m13      12-members

The underlined variables refer to hourly (or 3-hr) maximum. There are 103 total fields.

*Table 6. Ensemble post-processed products for NSSL/SPC*

Field	GEMPAK name	Unit	Type	Ens type
Sea level pressure	PMSL	hPa	Surface/single layer	Mean
Sea Level pressure Spread	MSLS	hPa	Surface/single layer	STDEV
850 hPa Z	HGHT850	m	Surface/single layer	Mean
500 hPa Z	HGHT500	m	Surface/single layer	Mean
500 hPa Z Spread	H500S	m	Surface/single layer	Mean
250 hPa Z	HGHT250	m	Surface/single layer	Mean
850 hPa u-wind	UREL850	m/s	Surface/single layer	Mean
850 hPa v-wind	VREL850	m/s	Surface/single layer	Mean
250 hPa u-wind	UREL250	m/s	Surface/single layer	Mean
250 hPa v-wind	VREL250	m/s	Surface/single layer	Mean
500 hPa u-wind	UREL500	m/s	Surface/single layer	Mean
500 hPa v-wind	VREL500	m/s	Surface/single layer	Mean
500 hPa absolute vorticity	AVORT500	1/s	Surface/single layer	Mean
1-h precip	P01M_PM	mm	Surface/single layer	PM-mean
1-h precip	P01M_M	mm	Surface/single layer	Mean
1-h precip	P01M_MX	mm	Surface/single layer	Max
1-h precip $\geq$ 0.25 in	PR01MTH1_P	%	Surface/single layer	Prob
1-h precip $\geq$ 0.50 in	PR01MTH2_P	%	Surface/single layer	Prob
1-h precip $\geq$ 1.00 in	PR01MTH3_P	%	Surface/single layer	Prob
6-h precip	P06M_PM	mm	Surface/single layer	PM-mean
6-h precip	P06M_M	mm	Surface/single layer	Mean
6-h precip	P06M_MX	mm	Surface/single layer	Max
6-h precip $\geq$ 0.5-in	PR06MTH2_P	%	Surface/single layer	Prob
6-h precip $\geq$ 1.0-in	PR06MTH3_P	%	Surface/single layer	Prob
6-h precip $\geq$ 2.0-in	PR06MTH4_P	%	Surface/single layer	Prob
Lowest model level temp	TMPF	F	Surface/single layer	Mean
Lowest model level dew point	DWPF	F	Surface/single layer	Mean

precipitable water	PWAT	mm	Surface/single layer	Mean
10 m U	UREL	m/s	Surface/single layer	Mean
10 m V	VREL	m/s	Surface/single layer	Mean
1 km AGL reflectivity	REFL1KM	dBZ	Surface/single layer	PM-mean
1 km refl $\geq$ 40 dBZ	REFL1KMT1_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>3-hr max 1 km refl <math>\geq</math> 40 dBZ</u>	REFL1KM_3h_PN	dBZ	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Composite reflectivity	REFLCMP	dBZ	Surface/single layer	PM-mean
Comp refl $\geq$ 40 dBZ	REFLCMPTH1_PN	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Surface-based CAPE	CAPE	J/kg	Surface/single layer	Mean
Surface-based CIN	CIN	J/kg	Surface/single layer	Mean
Surface-based LCL	HLCL	m	Surface/single layer	Mean
<u>Max Updraft helicity</u>	VHEL	$\text{m}^2/\text{s}^2$	Surface/single layer	Max
<u>Updraft helicity <math>\geq 25 \text{ m}^2/\text{s}^2</math></u>	VHEL25	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Updraft helicity <math>\geq 50 \text{ m}^2/\text{s}^2</math></u>	VHEL50	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Updraft helicity <math>\geq 75 \text{ m}^2/\text{s}^2</math></u>	VHEL75	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Updraft helicity <math>\geq 100 \text{ m}^2/\text{s}^2</math></u>	VHEL100	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Max Updraft helicity (3-hr)</u>	VHEL_3h	$\text{m}^2/\text{s}^2$	Surface/single layer	Max
<u>Updraft helicity (3 hr) <math>\geq 25 \text{ m}^2/\text{s}^2</math></u>	VHEL25_3hr	$\text{M}^2/\text{s}^2$	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Updraft helicity (3-hr) <math>&gt; 50 \text{ m}^2/\text{s}^2</math></u>	VHEL50_3h	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Updraft helicity(3-hr) <math>\geq 100 \text{ m}^2/\text{s}^2</math></u>	VHEL100_3h	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Max sfc-400 hPa W</u>	VVELMAX	m/s	Surface/single layer	Max
<u>Max sfc-400 hPa W <math>\geq 10 \text{ m/s}</math></u>	VVELMAX10	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)

<u>Max sfc-400 hPa W ≥ 20 m/s</u>	VVELMAX20	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Max sfc-400 hPa W (3-hr)</u>	VVELMAX_3h	m/s	Surface/single layer	Max
mlCAPE	MLCAPE	J/kg	Surface/single layer	Mean
mlCIN	MLCIN	J/kg	Surface/single layer	Mean
muCAPE	MUCAPE	J/kg	Surface/single layer	Mean
muCIN	MUCIN	J/kg	Surface/single layer	Mean
0 – 3 km AGL lapse rate	LLLR	K/km	Surface/single layer	Mean
700-500 mb lapse rate	LR75	K/km	Surface/single layer	Mean
<u>Max sfc-400 hPa W (3-hr) &gt; 10 m/s</u>	VVELMAX10_3h	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Max sfc-400 hPa W (3-hr) ≥ 20 m/s</u>	VVELMAX20_3h	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>0-3 km Updraft helicity</u>	<u>VHEL3KM</u>	$\text{m}^2/\text{s}^2$	Surface/single layer	Max
<u>0-3km updraft helicity &gt;= 20</u>	<u>VHEL3km20</u>	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>0-3 km Updraft helicity (3-hr)</u>	<u>VHEL3KM_3h</u>	$\text{m}^2/\text{s}^2$	Surface/single layer	Max
<u>0-3km Updraft helicity (3hr) &gt;= 20 m2/s2</u>	<u>VHEL3P_3h</u>	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
0-1 km AGL wind shear	SHR01	1/s	Surface/single layer	Mean
0-1 km AGL wind shear ≥ 10 m/s	SHR01_10	%	Surface/single layer	Prob
0-1 km AGL wind shear ≥ 15 m/s	SHR01_15	%	Surface/single layer	Prob
0-1 km AGL wind shear ≥ 20 m/s	SHR01_20	%	Surface/single layer	Prob
0-6 km AGL wind shear	SHR06	1/s	Surface/single layer	Mean
0-6 km AGL wind shear ≥ 15 m/s	SHR06_15	%	Surface/single layer	Prob
0-6 km AGL wind shear ≥ 20 m/s	SHR06_20	%	Surface/single layer	Prob
0-6 km AGL wind shear ≥ 25 m/s	SHR06_25	%	Surface/single layer	Prob
<u>Vertical-integrated Qg</u>	COLQG	$\text{kg}/\text{m}^2$	Surface/single layer	Max
<u>Vertical-integrated Qg ≥ 40</u>	COLQG40	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Vertical-integrated Qg (3-hr)</u>	COLQG_3h	$\text{kg}/\text{m}^2$	Surface/single layer	Max

<u>Vertical-integrated Qg (3-hr) ≥ 40</u>	COLQG40_3h	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Wind speed lowest model level</u>	<u>WMAGM</u>	m/s	Surface/single layer	Max
<u>Wind speed lowest model level (3-h)</u>	<u>WMAGM_3h</u>	m/s	Surface/single layer	Max
<u>Wind speed lowest model level (3-h) &gt;= 15 m/s</u>	<u>WMAGM15_3hr</u>	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Surface wind speed (10-m)</u>	WMAGSFC	m/s	Surface/single layer	Max
<u>Surface wind speed (10-m) ≥ 15 m/s</u>	WMAGSFC15	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Surface wind speed (10-m) &gt; 25 m/s</u>	WMAGSFC25	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Surface wind speed (10-m) (3-hr)</u>	WMAGSFC_3h	m/s	Surface/single layer	Max
<u>Surface wind speed (10-m) (3-hr) ≥ 15 m/s</u>	WMAGSFC15_3h	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
<u>Surface wind speed (10-m) (3-hr) ≥ 25 m/s</u>	WMAGSFC25_3h	%	Surface/single layer	Prob-neighbor (ROI=40, sigma=10)
Significant Tornado Parameter ≥ 1	SIGTOR1	%	Surface/single layer	Prob
Significant Tornado Parameter ≥ 3	SIGTOR3	%	Surface/single layer	Prob
Significant Tornado Parameter ≥ 5	SIGTOR5	%	Surface/single layer	Prob
Supercell Comp. Parameter ≥ 1	SCP1	%	Surface/single layer	Prob
Supercell Comp. Parameter ≥ 9	SCP9	%	Surface/single layer	Prob
IR Brightness Temp. ≤ -32C	BTN32	%	Surface/single layer	Prob
IR Brightness Temp. ≤ -52C	BTN52	%	Surface/single layer	Prob
Hail size	HAIL	in	Surface/single layer	Max
Hail Size > 0.25"	HAIL0	%	Surface/single layer	Prob neighbor (ROI=40, sigma=10)
Hail Size >= 1in"	HAIL1	%	Surface/single layer	Prob neighbor (ROI=40, sigma=10)
Hail Size >= 2in"	HAIL2	%	Surface/single layer	Prob neighbor (ROI=40, sigma=10)
Hail Size (3 hr)	HAIL_3H	in	Surface/single layer	Max
Hail Size >= 1in	HAIL1_3H	%	Surface/single layer	Prob neighbor (ROI=40, sigma=10)

Hail Size >= 2in	HAIL2_3H	%	Surface/single layer	Prob neighbor (ROI=40, sigma=10)
Clarkcon	CCON	m2/s2	Surface/single layer	Max
Clarkcon >= 50 m2/s2	CCON_p50	%	Surface/single layer	Prob neighbor (ROI=40, sigma=10)
Clarkcon >= 75m2/s2	CCON_p75	%	Surface/single layer	Prob neighbor (ROI=40, sigma=10)
Clarkcon >= 100 m2/s2	CCON_p100	%	Surface/single layer	Prob neighbor (ROI=40, sigma=10)

\* Highlighted variables in Tables 5 and 6 are not yet available.

### 4.3 Products that will be extracted and archived as 2D HDF4 files

Table 7 lists the 2D fields that are produced and archived in HDF4 format over the full domain for each ensemble member as well as the 1km forecast.

*Table 7. 2D fields archived for CAPS post-analysis*

Field	Variable name	Variable ID	Unit	Type	Level
Surface pressure	PRES	sfpres	hPa	Surface/single layer	0
Sea level pressure	PMSL	mspres	hPa	Surface/single layer	0
1-h precipitation	P01M	accpt	mm	Surface/single layer	0
Precipitable water	PWAT	pwat_	mm	Surface/single layer	0
2 m temperature	TMPF	temp2m	F	Surface/single layer	0
2 m dew point	DWPF	dewp2m	F	Surface/single layer	0
2 m mixing ratio	MIXR	qv2m_	g/kg	Surface/single layer	0
1st level temperature	TMPF	tempk2	F	Surface/single layer	0
1st level dew point	DWPF	dewpk2	F	Surface/single layer	0
1st level mixing ratio	MIXR	qvk2_	g/kg	Surface/single layer	0
<u>1<sup>st</sup> level wind speed</u>	<u>WMAGM</u>	wsp2mx	m/s	Surface/single layer	0
10 m U	UREL	u10m_	m/s	Surface/single layer	0
10 m V	VREL	v10m_	m/s	Surface/single layer	0
Surface wind speed (10-m)	WMAGSFC	wspmax	m/s	Surface/single layer	0

<u>Wind speed (1-km)</u>	<u>WMAG1KM</u>	wsp1km	m/s	Surface/single layer	0
Surface geo- height	HGHT	hgtsfc	m	Surface/single layer	0
1 km AGL reflectivity	REFL1KM	ref1km	dBZ	Surface/single layer	0
<u>1 km AGL reflectivity</u>	<u>REFL1KM_HM</u>	refmax	dBZ	Surface/single layer	0
4 km AGL reflectivity	REFL4KM	ref4km	dBZ	Surface/single layer	0
Composite reflectivity	REFLCMP	cmpref	dBZ	Surface/single layer	0
<u>Composite reflectivity</u>	<u>REFLCMP_HM</u>	crefmx	dBZ	Surface/single layer	0
<u>Reflectivity at -10C</u>	<u>REFLMTR</u>	r10cmx	dBZ	Surface/single layer	0
Surface-based CAPE	CAPE	sbcape	J/kg	Surface/single layer	0
Moist unstable CAPE	MUCAPE	mucape	J/kg	Surface/single layer	0
Mixed-layer CAPE	MLCAPE	mlcape	J/kg	Surface/single layer	0
Surface-based CIN	CINS	sbcins	J/kg	Surface/single layer	0
Moist unstable CIN	MUCINS	mucins	J/kg	Surface/single layer	0
Mixed-layer CIN	MLCINS	mleins	J/kg	Surface/single layer	0
Surface-based LCL	HLCL	sblcl_	m	Surface/single layer	0
0-1 km AGL SRH	SRH01	srh01_	m <sup>2</sup> /s <sup>2</sup>	Surface/single layer	0
0-3 km AGL SRH	SRH03	srh03_	m <sup>2</sup> /s <sup>2</sup>	Surface/single layer	0
<u>Updraft helicity</u>	<u>VHELMAX</u>	uh_max	m <sup>2</sup> /s <sup>2</sup>	Surface/single layer	0
<u>Updraft helicity - E</u>	<u>VHELE</u>	uhemax	m <sup>2</sup> /s <sup>2</sup>	Surface/single layer	0
<u>Updraft helicity - P</u>	<u>VHELF</u>	uhpmax	m <sup>2</sup> /s <sup>2</sup>	Surface/single layer	0
<u>0-3km Updraft helicity</u>	<u>VHEL3KM</u>	uh03mx	m <sup>2</sup> /s <sup>2</sup>	Surface/single layer	0
<u>Sfc-400hPa max W</u>	<u>VVELMAX</u>	wupmax	m/s	Surface/single layer	0
<u>Sfc-400hPa min W</u>	<u>VVELMIN</u>	wdnmax	m/s	Surface/single layer	0
0-1 km AGL wind shear	SHR01	shr01_	1/s	Surface/single layer	0
0-6 km AGL wind shera	SHR06	shr06_	1/s	Surface/single layer	0
1-h accumulated snow	SNOW	snow01	mm	Surface/single layer	0
1-h accumulated graupel	GRAUP	grpl01	mm	Surface/single layer	0

1-h accumulated hail	HAIL	hail01	mm	Surface/single layer	0
Bunkers right-moving U	BKU	bku_	m/s	Surface/single layer	0
Bunkers right-moving V	BKV	bkv_	m/s	Surface/single layer	0
Echo top (>= 18 dBZ)	ECHOTOP	echotp	km	Surface/single layer	0
<u>Vertical-integrated Qs</u>	<u>COLQS</u>	cqsmax	kg/ m <sup>2</sup>	Surface/single layer	0
<u>Vertical-integrated Qg</u>	<u>COLQG</u>	cqgmax	kg/ m <sup>2</sup>	Surface/single layer	0
<u>Vertical-integrated Qg (0-5km)</u>	<u>LLQG</u>	llqg05	kg/ m <sup>2</sup>	Surface/single layer	0
<u>0-3km lapse rate</u>	<u>LLLR</u>	lllr_	K/km	Surface/single layer	0
700-500hPa lapse rate	LR75	lr75_	K/km	Surface/single layer	0
100 m U	U100M	u100m_	m/s	Surface/single layer	0
100 m V	V100M	v100m_	m/s	Surface/single layer	0
Sfc downward radiation flux	RADDN	raddn_	W/ m <sup>2</sup>	Surface/single layer	0
Qs above surface	QSSFC	qsk2_	g/kg	Surface/single layer	0
Qg above surface	QGSFC	qgk2_	g/kg	Surface/single layer	0
Qh above surface	QHSFC	qhk2_	g/kg	Surface/single layer	0
Ns above surface	QNSSF	qnsk2_	g/kg	Surface/single layer	0
Ng above surface	QNGSFC	qngk2_	g/kg	Surface/single layer	0
Nh above surface	QNHSFC	qnhk2_	g/kg	Surface/single layer	0
Qt above surface	QTSFC	qtsfc_	g/kg	Surface/single layer	0
<u>Hail size</u>	<u>HAILSIZ</u>	hailsz	mm	Surface/single layer	0
500 hPa absolute vorticity	VORT500	vr500	1/s	Surface/single layer	0
Lightning flash rate	LTG_MAX	Lg_max	Flashes/km <sup>2</sup> /5 min	Surface/single layer	0
LFC height	LFCH	lfch_	m	Surface/single layer	0
PBL height	PBLH	pblh_	m	Surface/single layer	0
W at PBL top	WPBL	wpbl_	m/s	Surface/single layer	0
Simulated satellite BT Ch 3.90 CRTM	SIMSAT1	btch01	K	Surface/single layer	0
Simulated satellite BT Ch 6.48 CRTM	SIMSAT2	btch02	K	Surface/single layer	0

Simulated satellite BT Ch 10.67 CRTM	SIMSAT3	btch03	K	Surface/single layer	0
Geopotential height 850	HGHT	hgt850	m	pressure	850 hPa
Geopotential height 700	HGHT	hgt700	m	pressure	700 hPa
Geopotential height 600	HGHT	hgt600	m	pressure	600 hPa
Geopotential height 500	HGHT	hgt500	m	pressure	500 hPa
Geopotential height 250	HGHT	hgt250	m	pressure	250 hPa
850 hPa U	UREL	u850_	m/s	pressure	850 hPa
700 hPa U	UREL	u700_	m/s	pressure	700 hPa
600 hPa U	UREL	u600_	m/s	pressure	600 hPa
500 hPa U	UREL	u500_	m/s	pressure	500 hPa
250 hPa U	UREL	u250_	m/s	pressure	250 hPa
850 hPa V	VREL	v850_	m/s	pressure	850 hPa
700 hPa V	VREL	v700_	m/s	pressure	700 hPa
600 hPa V	VREL	v600_	m/s	pressure	600 hPa
500 hPa V	VREL	v500_	m/s	pressure	500 hPa
250 hPa V	VREL	v250_	m/s	pressure	250 hPa
850 hPa W	VVEL	w850_	m/s	pressure	850 hPa
700 hPa W	VVEL	w700_	m/s	pressure	700 hPa
600 hPa W	VVEL	w600_	m/s	pressure	600 hPa
500 hPa W	VVEL	w500_	m/s	pressure	500 hPa
250 hPa W	VVEL	w250_	m/s	pressure	250 hPa
850 hPa T	TMPC	tmp850	C	pressure	850 hPa
700 hPa T	TMPC	tmp700	C	pressure	700 hPa
600 hPa T	TMPC	tmp600	C	pressure	600 hPa
500 hPa T	TMPC	tmp500	C	pressure	500 hPa
250 hPa T	TMPC	tmp250	C	pressure	250 hPa
850 hPa mixing ratio	MIXR	sph850	g/kg	pressure	850 hPa
700 hPa mixing ratio	MIXR	sph700	g/kg	pressure	700 hPa
600 hPa mixing ratio	MIXR	sph600	g/kg	pressure	600 hPa

500 hPa mixing ratio	MIXR	sph500	g/kg	pressure	500 hPa
250 hPa mixing ratio	MIXR	sph250	g/kg	pressure	250 hPa

#### 4.4 Name convention

*SPC/NSSL file name*                           *CAPS web name*

ARW members:

ssef_s4cn_arw_2012041500	SPC4-EF CN WRFARW Fcst
ssef_s4c0_arw_2012041500	SPC4-EF C0 WRFARW Fcst
ssef_s4m3_arw_2012041500	SPC4-EF M3 WRFARW Fcst
ssef_s4m4_arw_2012041500	SPC4-EF M4 WRFARW Fcst
ssef_s4m5_arw_2012041500	SPC4-EF M5 WRFARW Fcst
ssef_s4m6_arw_2012041500	SPC4-EF M6 WRFARW Fcst
ssef_s4m7_arw_2012041500	SPC4-EF M7 WRFARW Fcst
ssef_s4m8_arw_2012041500	SPC4-EF M8 WRFARW Fcst
ssef_s4m9_arw_2012041500	SPC4-EF M9 WRFARW Fcst
ssef_s4m10_arw_2012041500	SPC4-EF M10 WRFARW Fcst
ssef_s4m11_arw_2012041500	SPC4-EF M11 WRFARW Fcst
ssef_s4m12_arw_2012041500	SPC4-EF M12 WRFARW Fcst
ssef_s4m13_arw_2012041500	SPC4-EF M13 WRFARW Fcst
ssef_s4m14_arw_2012041500	SPC4-EF M14 WRFARW Fcst
ssef_s4m15_arw_2012041500	SPC4-EF M15 WRFARW Fcst
ssef_s4m16_arw_2012041500	SPC4-EF M16 WRFARW Fcst
ssef_s4m17_arw_2012041500	SPC4-EF M17 WRFARW Fcst
ssef_s4m18_arw_2012041500	SPC4-EF M18 WRFARW Fcst
ssef_s4m19_arw_2012041500	SPC4-EF M19 WRFARW Fcst

ssef_s4m20_arw_2012041500	SPC4-EF M20 WRFARW Fcst
ssef_s4m21_arw_2012041500	SPC4-EF M21 WRFARW Fcst
ssef_s4m22_arw_2012041500	SPC4-EF M22 WRFARW Fcst
ssef_s4m23_arw_2012041500	SPC4-EF M23 WRFARW Fcst

ARPS members:

ssef_arps_cn_2012041500	SPC4-EF CN ARPS Fcst
-------------------------	----------------------

COAMPS members:

ssef_cmps_cn_2012041500	SPC4-EF CN COAMPS Fcst
ssef_cmps_c0_2012041500	SPC4-EF C0 COAMPS Fcst
ssef_cmps_c1_2012041500	SPC4-EF C1 COAMPS Fcst

Ensemble summary product:

ssef_s4ens_2010043000	(12-member)
-----------------------	-------------

## 5. 3D Visualization

(Keith)

# **Appendix**

## *A.1 WRF-ARW timing*

## *A.2 ARPS timing*

## *A.3 COAMPS timing*

## *A.4 List of SREF members (New – beginning August 2012)*

18 perturbed members:

sref\_em\_n1  
sref\_em\_p1  
sref\_em\_n2  
sref\_em\_p2  
sref\_em\_n3  
sref\_em\_p3  
sref\_nmb\_n1  
sref\_nmb\_p1  
sref\_nmb\_n2  
sref\_nmb\_p2  
sref\_nmb\_n3  
sref\_nmb\_p3  
sref\_nmm\_n1  
sref\_nmm\_p1  
sref\_nmm\_n2  
sref\_nmm\_p2  
sref\_nmm\_n3  
sref\_nmm\_p3

3 control members:

sref\_em\_ctl (WRF-ARW)  
sref\_nmm\_ctl (WRF-NMM)  
sref\_nmb\_ctl (NMMB)